R/V KNORR CRUISE NUMBER 13, OCTOBER 7-21, 1970

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Woods Hole Oceanographic Institution

Prepared for:

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13. ABSTRACT

KNORR 13 was a scheduled buoy cruise, made during October, 1970. The objective of the cruise was to deploy and recover instrumented deep-sea moorings. Buoy Stations 343, 344, 345, 348, and 349 were recovered. Stations 352, 353, 354, and 355 were set. In addition, one mooring at 35°44'N, 70°37'W was recovered for the University of Rhode Island. Mooring work was performed at Sites D, J, and L and on the Continental Slope in position 39°58'N, 70°56'W. A topographic survey was made in the immediate area of a three-mooring array located on the Continental Slope. Hydrographic stations were taken along the 71°W meridian between 39°N and 40°N. A 23-hour CCTD station was made in position 39°N, 71°W. Surface plankton tows were made daily.

35 deg 44 min N
70 deg 37 min W
70 deg 56 min W
39 deg 50 min N
degrees
degrees

DD FORM 1 JAN 64 1473

I

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
1. Moorings						
2. Ocean Currents						
3. Buoys						

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WHOI-72-80

R/V KNORR CRUISE NO. 13
OCTOBER 7 - 21, 1970

Chief Scientist
Donald A. Moller

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts 02543

November 1972

TECHNICAL REPORT

Prepared for the Office of Naval Research under Contract N00014-66-C0241; NR 083-004.

Approved for Distribution Ferris Webster

Ferris Webster, Chairman
Department of Physical Oceanography

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Acknowledgements

The assistance and effort of all those persons who contributed to the success of the cruise are gratefully acknowledged. The willingness of Captain Hiller and the Marine Department of the Institution to allow Knorr to complete the scientific program of the cruise despite major engineering problems is greatly appreciated.

The work was supported by the Office of Naval Research Contract N00014-66-CG241 NR 083.

1. Summary of Experiments

1. Low-frequency wave correlations across the Gulf Stream (Schmitz and Webster) -- As part of a continuing program, moored Stations 343 and 345 were recovered and Stations 352 and 353 were set.

2. Near-bottom internal wave propagation across the Continental Slope (Wunsch) -- Two Moorings (Stations 348 and 349) of a three-mooring array centered in position 39°50'N, 70°56'W were recovered. A detailed topographic survey was made in the immediate area of the array.

3. Engineering evaluation of intermediate mooring design (Walden) -- Moored Stations 343 and 345 were recovered.

4. Engineering evaluation and test of mooring wire and hardware (Walden, Berteaux) -- Station 344, an engineering surface mooring at Site L, was recovered.

5. Engineering evaluation of the fishbite resistance of PVC-jacketed dacron mooring line (Stimson) -- Station 355, a two-month surface mooring, was set at Site L.

6. A test of the corrosion resistance of mooring components (Berteaux) -- Station 354, a six-month bottom mooring, was set at Site L.

7. A hydrographic station section was made between 39°N and 40°N along 71°W (Stations 36 through 43) (Volkmann).

8. A prolonged (23-hour) CCTD station was taken at position 39°N, 71°W. Continuous lowerings from the surface to the 160-meter level were made in an attempt to define the density structure. Every fourth lowering was made to 700 meters. An XBT survey was made to define the temperature structure of the area (Volkmann).

9. An XBT section of the Gulf Stream was made on both the northbound and the southbound crossings (Parker).

10. Surface plankton tows were made daily for a study of copepod densities (Walker).

11. Studies of the growth rates and life processes of marine bacteria at oceanic depths (Jannasch) -- A package containing bacteria samples was placed on Station 354 at a depth of 5300 meters.

2. Chronological Order of Events

5 October 1410	Depart Woods Hole
6 October 0020	Arrive Continental Slope array
6 October 0020-0815	Topographic survey
6 October 0830-0850	Recover Station 348
6 October 0917-0945	Recover Station 349
6 October 0955	Aft cycloid fails
6 October 1100	Depart Continental Slope array
6 October 1315	Arrive Site D
6 October 1329-1645	Recover Station 345
6 October 1815-1818	Set Station 352
6 October 1850	Depart Site D
6 October 1855-1915	Plankton tow #1
7 October 1900-1920	Plankton tow #2
8 October 0355	Arrive at Site J
8 October 0854-0859	Set Station 353
8 October 0910-0925	Plankton tow #3
8 October 0948-1315	Recover Station 343
8 October 1330	Depart Site J
8 October 1945-2005	Plankton tow #4
9 October 1350-1410	Plankton tow #5
9 October 1500	Arrive Site L
9 October 1657-1659	Set Station 354
9 October 1854-2028	Set Station 355
9 October 2220 - 10 October 0153	Recover Station 344
10 October 0220-0700	Hydro station #35
10 October 0830	Depart Site L
10 October 1405-1425	Plankton tow #6
11 October 0715-1020	Recover U.R.I. mooring
11 October 1630-1730	Test lower CCTD
11 October 2000-2020	Plankton tow #7
12 October 1730 - 13 October 1600	CCTD station #1

13 October 2020 - 14 October 1615	Hydro stations 36-43
14 October 0200-0215	Plankton tow #8
14 October 1510-1530	Plankton tow #9
15 October 0600	Arrive Woods Hole

3. Moored Stations

Station 343

Station 343 was an intermediate-depth mooring set in position 35°58'N, 70°33'W (Site J) on August 13, 1970. Two experiments were conducted with this mooring: a correlation of low-frequency waves across the Gulf Stream with Station 345 and an engineering evaluation of the capabilities and design of this type of mooring. Instruments were placed at the following depths:

Depth recorder	2261 meters
Current meter	2263 meters
Inclinometer	3185 meters
Current meter (dummy)	4107 meters
Current meter	4115 meters
Tension recorder	4412 meters

The mooring was released on the morning of October 8, 1970. The orange hard hats of the main floatation contributed significantly to an early sighting under adverse conditions. The radio malfunctioned.

Water noise generated by the bow propulsion unit and porpoise chatter prevented the use of the AMF full-mounted transducer during recovery. It was necessary to secure the forward cycloid when attempting to use the hull transducer. The problem of porpoise chatter could not be overcome.

The recovery winch failed during this retrieval operation. Hauling was transferred to the ship's capstan and then to the gypsy head of the hydrographic winch which was faster. The line was allowed to spill into barrels and garbage cans to be spooled onto reels later.

Station 344

Station 344 was a two-month surface mooring set at Site L in August, 1970 as an engineering evaluation of mooring wire and hardware. The mooring was instrumented as follows:

Telemetering tensiometer	surface
Current meter (speed only)	13 meters
Tension recorder	14 meters
Tension recorder	5248 meters

The mooring was released at 2220 on October 9, 1970, and recovery was completed at 0153 on October 10. There was a moderate sea of 10-12 feet running during this operation. A heavy-duty, V-shaped stopper which was rigidly mounted on the side of the ship was used to engage the upper 10 meter shot of chain. This stopper took the strain off the mooring during the initial lifting operation, enabling the main float to be detached from the mooring with ease and safety.

The acoustic beacon leaked oil and was not working when recovered. The radio was operating correctly but had no tension pulse. The plug at the lower end of the electrical cable that connected the tension cell to the radio was fractured. There was evidence of fishbite on the upper 1000 meters of wire.

Station 345

Station 345 was an intermediate depth mooring set in position 39°23'N, 70°59'W on August 18, 1970. This mooring was set with Station 343, for an experiment involving the correlation of low-frequency waves across the Gulf Stream. The mooring was instrumented for an engineering evaluation of intermediate mooring motions. The mooring was instrumented as follows:

Current meter	1504 meters
Depth recorder	1505 meters
Inclinometer	1960 meters
Current meter (dummy)	1972 meters
Current meter	2434 meters
Tension recorder	2495 meters

The release was fired at 1329 on October 6, 1970, and the main floatation reached the surface 19 minutes later. An error

in noting the position of the mooring placed the vessel 5 miles north of the true mooring site. The improper positioning of the vessel, severe water noise and porpoise chatter made it difficult to locate the mooring. The mooring was finally tracked down by means of direction finding on the radio and towed hydrophones. Recovery was completed without incident by 1644.

Station 348

Station 348 was part of a three-mooring array located at position 39°50'N, 70°56'W. The mooring was set in August, 1970, with Stations 349 and 350 as an experiment designed to study near-bottom internal wave propagation across the Continental Slope. Fig. 1 shows the position of the mooring in the array. The mooring contained 2 current meters, one 10 meters off the bottom and the other 3 meters off the bottom.

The mooring was released at 0850 on October 6, 1970. The float surfaced twelve minutes later, 200 yards astern. Because the mooring was short (14 meters), it was possible to recover it in one lift.

Station 349

Station 349 was one of three moorings (348, 349, 350) placed in position 39°50'N, 70°56'W as part of an array designed to investigate near-bottom internal wave propagation on the Continental Slope. Fig. 1 shows the position of the mooring within the array. The mooring had current meters at 97 meters, 10 meters, and 1.5 meters from the bottom. A modified acoustic release was used that enabled the lower current meter to be placed within two meters of the bottom.

The release was fired at 0917 on October 6, 1970. The mooring was tracked acoustically as it rose to the surface. The float broached nine minutes after release, 30 yards off the port bow and was recovered without incident.

University of Rhode Island Mooring

A bottom mooring designed and equipped by the University of Rhode Island had been set in position 35°44'N, 70°37'W on June 29, 1970. It was requested that this mooring, with one current meter, be recovered on this cruise.

The mooring was released at 0715 on October 11, 1970, on the fourth attempt. Because of its limited positive buoyancy, the buoy required 2 hours 13 minutes to reach the surface. The float was sighted ten minutes after surfacing, and recovery was completed without incident at 1030.

The aluminum float and mooring components where dissimilar metals came in contact with each other were badly corroded. The worst corrosion occurred where steel shackles were in contact with bronze thimbles.

Station 352

This station was a bottom mooring set in position 39°23'N, 71°01'W on October 6, 1970 as a continuing experiment investigating near-bottom low-frequency wave correlation across the Gulf Stream (with 353). It contained one current meter, 100 meters off the bottom. The mooring was scheduled for a two-month deployment.

Station 353

Station 353 was a bottom mooring set in position 35°58'N, 70°35'W on October 8, 1970. Together with Station 352, it was a continuation of the experiment investigating near-bottom, low-frequency internal waves correlation across the Gulf Stream. One current meter was placed 100 meters off the bottom. The mooring was scheduled for a two-month deployment.

Station 354

This mooring was set as a six-month test of the corrosion resistance of mooring components and hardware. The buoy was deployed in position 34°02'N, 69°59'W (Site L) on October 9, 1970. Placed on the mooring for testing were an 850 current

meter, a dummy VACM, a dummy tension recorder, and titanium samples. In addition, a "bio-pack" was attached to the mooring. This package contained bacteria cultures which were to be used in a study of growth rates and life processes at oceanic depths.

Station 355

Station 355 was set on October 9, 1970, in position 34°02'N, 69°54'W (Site L). The mooring was one of a series of moorings designed to test the fishbite resistance of jacketed synthetic line. Except for a telemetering tensiometer, the mooring was not instrumented. Recovery was scheduled for December, 1970.

General

Moorings were set and recovered by procedures established by the W.H.O.I. Moored Array project. Departures from these standards were the recovery of Station 348 in a single lift by means of the ship's crane and the stopping off of the surface float of Station 344 in the rigid V-shaped stopper. The failure of the rehaul winch during the recovery of Station 343 was the only serious problem experienced during the cruise. Before deploying each mooring, the release was lowered to the bottom on the hydrographic wire where it was tested for proper performance.

4. Topographic Survey on the Continental Slope

An array composed of moored Stations 348, 349, and 350 was set on the Continental Slope in position 39°50'N, 70°56'W on August 19, 1970. The moorings were closely spaced on a steep slope with current meters located two and three meters off the bottom. The experiment was a study of internal wave propagation across the Continental Slope. In order to make the results of the experiment more meaningful, the relative position of the moorings and the details of the bottom topography in the immediate area of the array had to be known.

It was intended that the relative positions of the stations, which were all bottom moorings, be determined and then, using the moorings as reference points, a topographic survey be made around the array. Acoustic ranging on the transponding release of each mooring provided a means of positioning the moorings relative to each other and of navigating the vessel relative to the array.

The task of positioning the moorings was done in two stages. First, the vessel was maneuvered into position over Station 349. The direction and slant ranges of the other two moorings were noted and a depth sounding was taken. This procedure was repeated over Stations 348 and 350. The result was a usable approximation of the mooring positions for planning the next stage. The second stage consisted of placing the vessel one mile distant from the moorings and getting underway on a steady course at a constant speed, passing the moorings down the port side. During this run frequent measurements of the ranges to each of the moorings were made. Plotting these ranges on a maneuvering board gave intersections at the positions of the moorings. This procedure appears to have positioned the moorings with respect to each other with an accuracy of ±25 meters. Figure 1 shows the relative positions of the moorings in the array.

Once the positions of the moorings were determined, the topographic survey was started. Five north-south legs, each aprpoximately three miles long and one-half mile apart, were made, bracketing the array. The north-south legs were tied together by two east-west legs. Constant course and speed were maintained on each leg. A Gifft depth recorder was used to obtain a continuous echo-sounding profile. Acoustic ranges and bearings to the three moorings were taken at the beginning and end of each leg for navigation. Fig. 2 is a chartlet of the survey area showing 20-meter contours, ship's track, and the position of the array.

5. Hydrographic and CCTD Stations

It has been standard procedure on buoy cruises to take a section of hydrographic stations over the Continental Slope to provide a long time series and history of the area. The section is usually made between 39°N and 40°N along 70°W with stations spaced every ten miles. Depth of water ranges from 200 meters to 3200 meters. On this cruise the section was made on 13-14 October along the 71°W meridian. It consisted of Stations 36 through 43.

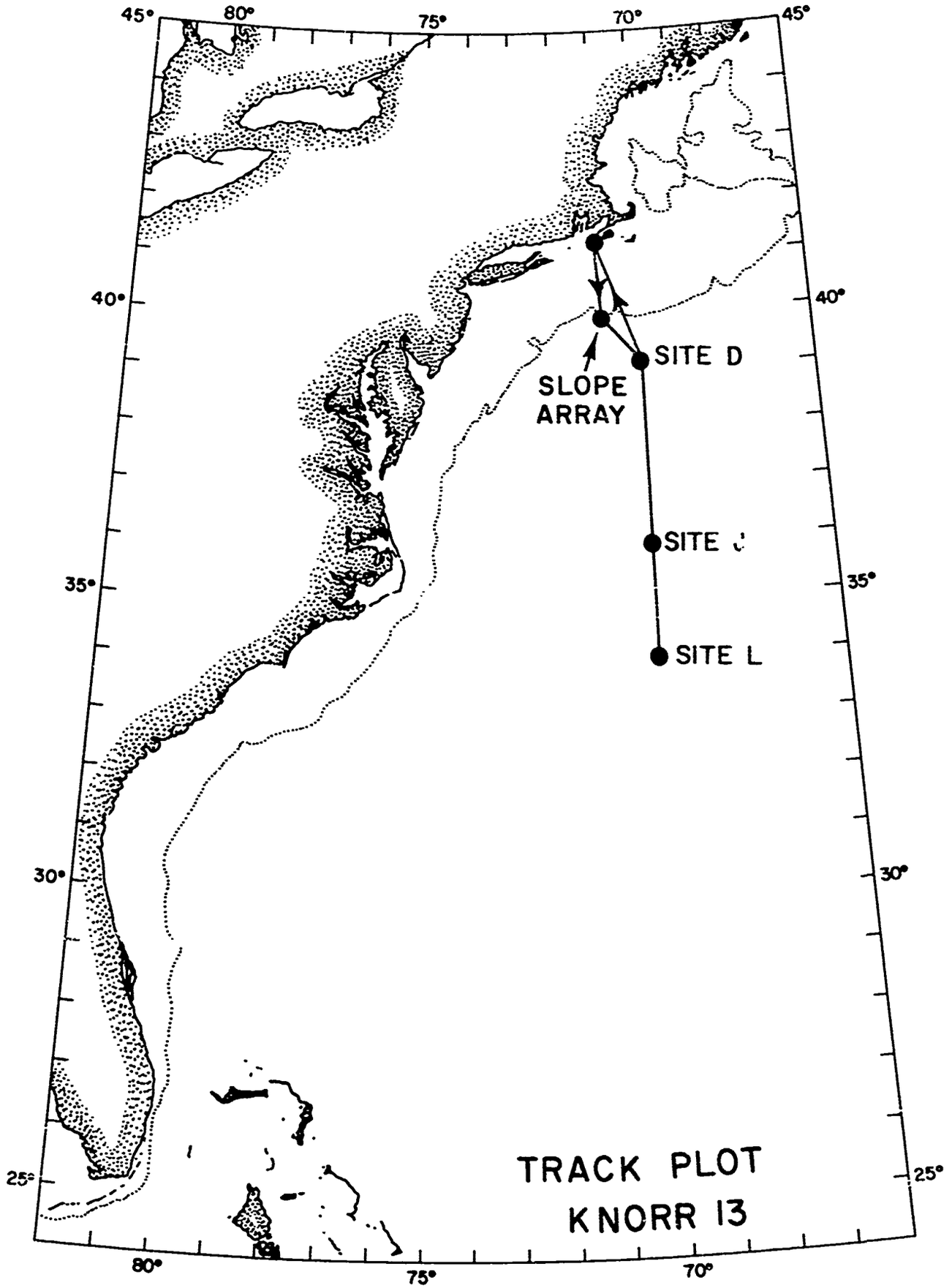
A prolonged CCTD cast (23 hours) was made in the vicinity of 39°N, 71°W. To observe the density structure continuous lowerings from the surface to 160 meters were made. XBT's were used to define the temperature structure. An XBT section of the Gulf Stream was made on both the northbound and southbound crossings. Surface plankton tows were made daily.

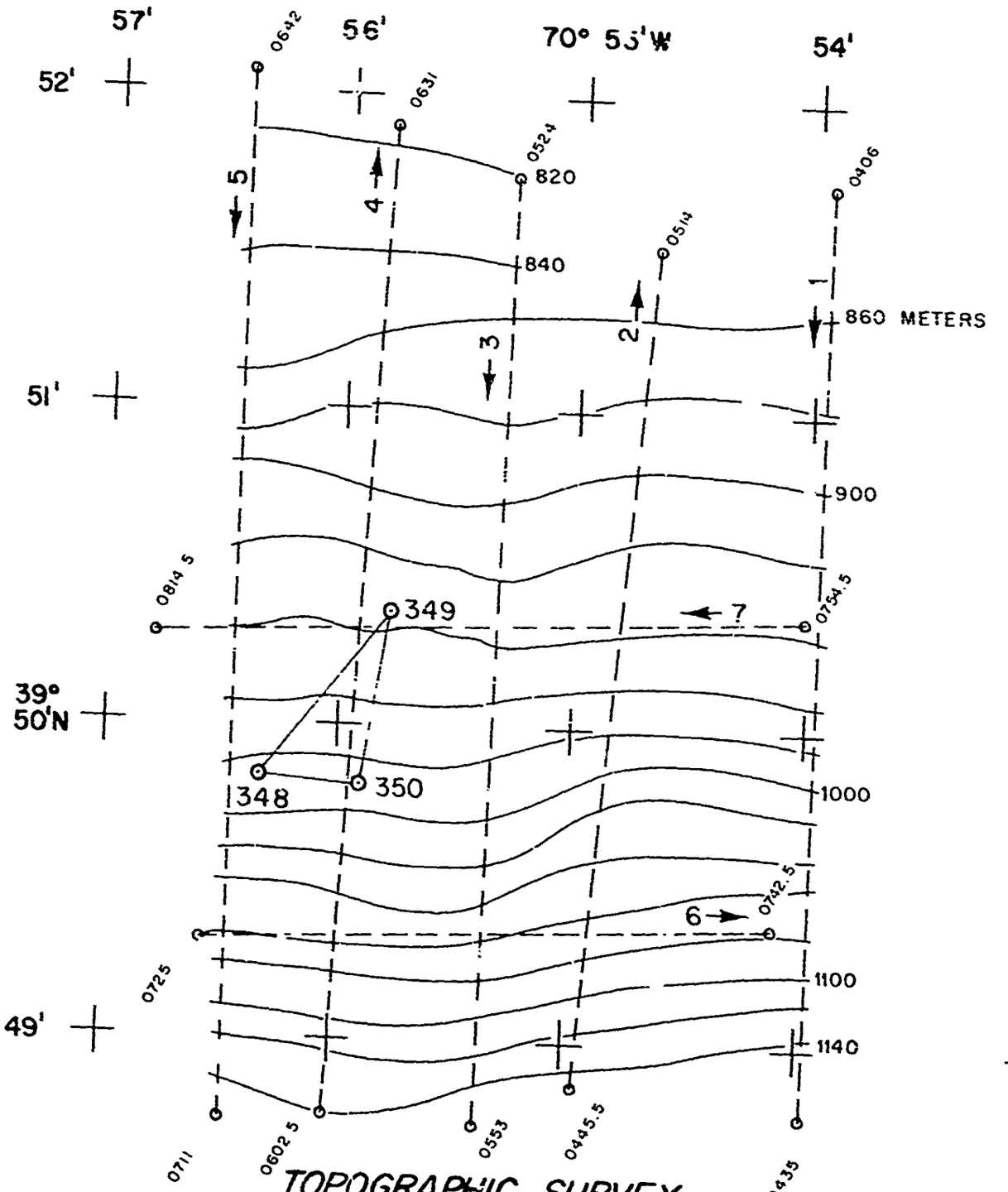
6. Personnel

Mr. Donald Moller
Mr. Gordon Volkmann
Mr. Robert Walden
Mr. Henri Berteaux
Mr. Charles Parker
Mr. Harold Armstrong
Mr. George Tupper
Mr. Michael Kelley
Miss Louise Agen
Miss Caroline Harlow
Mr. Allan Davison
Miss Mary Clare Walker (New York University)
Mr. Roger Evans (M.I.T./W.H.O.I.)
Mr. Daniel Charnews (M.I.T./W.H.O.I.)
Mr. Ronald Gularte (M.I.T./W.H.O.I.)

SUMMARY OF MOORINGS AT SEA
as of October Cruise, 1970
Knorr 13

No.	Type	Set	Equipment	Remarks
346	Bottom - Syntactic Cylinder	18-VIII-70	1 Current Meter 1 Acoustic Release, Transponding, AMF	One of a three-mooring array to study the topographical wave motion across the Continental Slope, for Schmitz
347	Bottom - Syntactic Rectangle	19-VIII-70	1 Current Meter 1 Acoustic Release, Transponding, AMF	The second in the Schmitz Slope array
350	Bottom - Glass Spheres	19-VIII-70	2 Current Meters 1 Acoustic Release, Transponding, AMF	One of a three-mooring array to observe internal waves across the Slope for Wunsch. All three were set in August and the other two retrieved on this cruise
351	Bottom - Glass Spheres	19-VIII-70	1 Current Meter 1 Acoustic Release, Transponding, AMF	The third in the Schmitz array
352	Bottom - Glass Spheres	6-X-70	1 Current Meter 1 Acoustic Release, Transponding, AMF	One of two bottom moorings to collect low-frequency wave correlation data across the Gulf Stream for Schmitz, Fofonoff and Webster
353	Bottom - Syntactic Rectangle	8-X-70	1 Current Meter 1 Acoustic Release, Transponding, AMF	The second of the Schmitz, Fofonoff and Webster moorings
354	Bottom - Glass Spheres	9-X-70	1 Current Meter 1 Acoustic Release, Transponding, AMF	Six-month mooring combining corrosion tests for Walden and Berteaux and bottom current measurements for Schmitz and Tupper
355	Surface - Conical	9-X-70	1 Tension Cell 1 Tensiometer 1 Acoustic Release, Transponding, AMF	Two-month fishbite test for Stimson


45°
80°
75°
70°
45°
40°
40°
SITE D
SLOPE
ARRAY
SITE J
35°
35°
SITE L
30°
30°
25°
25°
80°
75°
70°
TRACK PLOT
KNORR 13

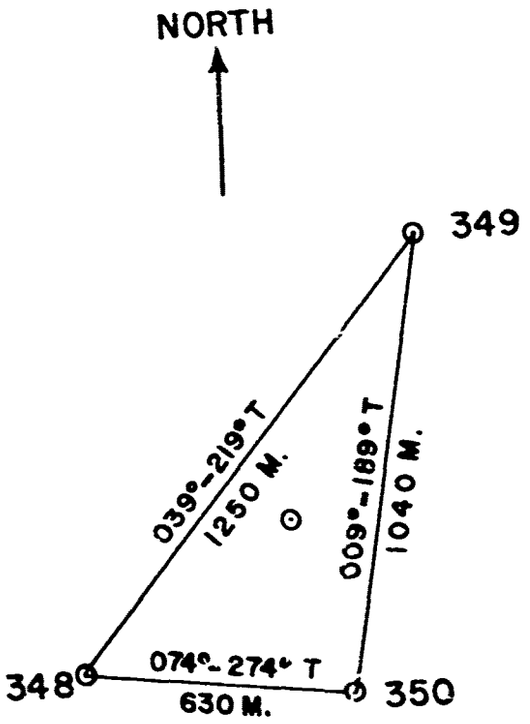


TOPOGRAPHIC SURVEY

AREA OF CONTINENTAL SLOPE ARRAY

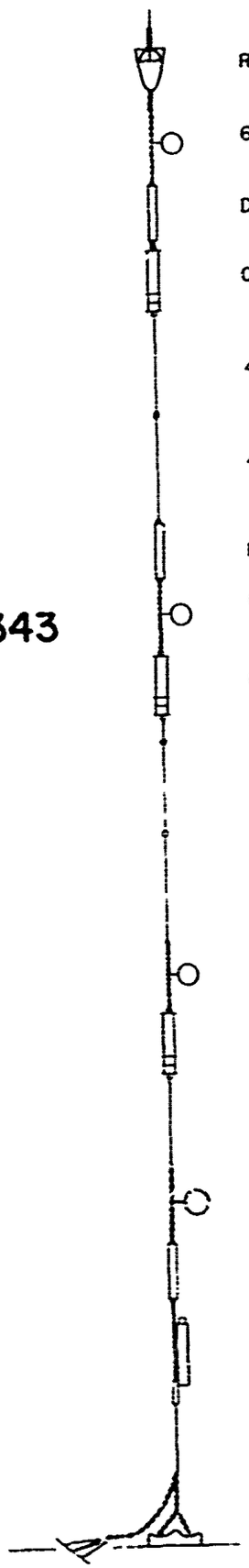
KNORR 13

SLOPE ARRAY
RELATIVE POSITIONS



CENTRAL
POSITION
39°-50' N
70°-56'W

STATION 343



RADIO FLOAT

6 m 1/4" CHAIN WITH 8 16" SPHERES EVENLY SPACED

DEPTH RECORDER - *3431*

CURRENT METER - *3432*

440 m 3/8" DACRON

482 m 3/8" DACRON

INCLINOMETER - *3433*

6 m 1/4" CHAIN WITH 8 16" SPHERES EVENLY SPACED

CURRENT METER, DUMMY

18 m 3/8" DACRON

413 m 3/8" DACRON

483 m 3/8" DACRON

6 m 1/4" CHAIN WITH 7 16" SPHERES EVENLY SPACED

CURRENT METER - *3434*

290 m 9/16" NYLON

6 m 3/8" CHAIN WITH 7 16" SPHERES EVENLY SPACED

TENSIOMETER - *3435*

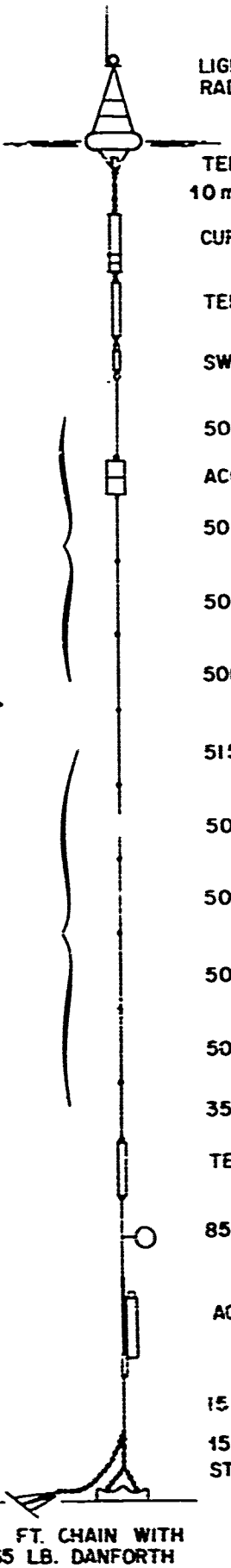
ACOUSTIC RELEASE, TRANSPONDING

20 m 3/4" NYLON

10 m 1/2" CHAIN

STIMSON ANCHOR, 3,100 LBS.

15 FT CHAIN WITH 65 LB. CANFORTH

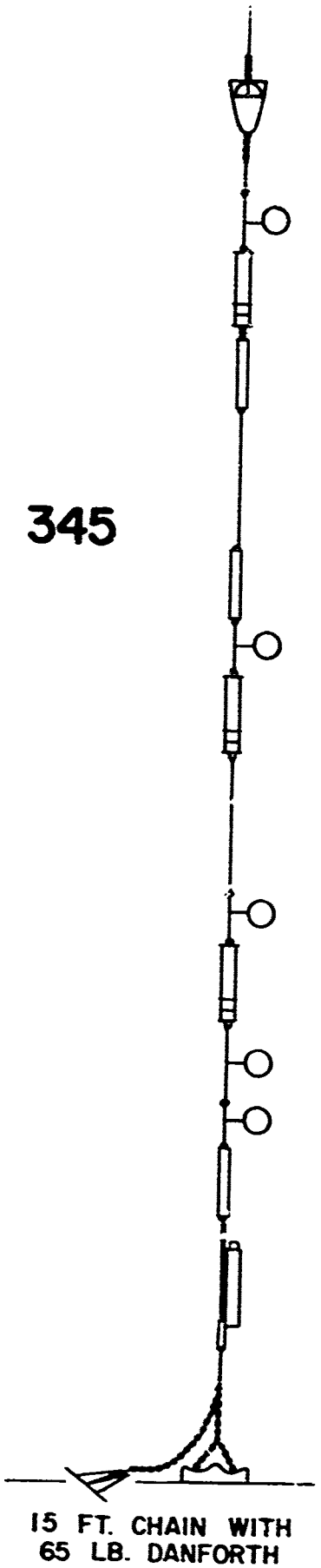


WIRE ROPE

5/8" NYLON

STATION 344

STATION 345



RADIO FLOAT

1 m 3/4" NYLON

10 m 9/16" NYLON WITH 5 GLASS SPHERES

CURRENT METER - *3451*

DEPTH RECORDER - *3452*

454 m 3/8" DACRON

INCLINOMETER - *3453*

10 m 9/16" NYLON WITH 6 GLASS SPHERES

CURRENT METER (DUMMY)

450 m 3/8" DACRON

10 m 9/16" NYLON WITH 5 GLASS SPHERES

CURRENT METER - *3454*

50 m 9/16" NYLON WITH 1 GLASS SPHERE

10 m 9/16" NYLON WITH 5 GLASS SPHERES

TENSIOMETER - *3455*

ACOUSTIC RELEASE,
TRANSPONDING

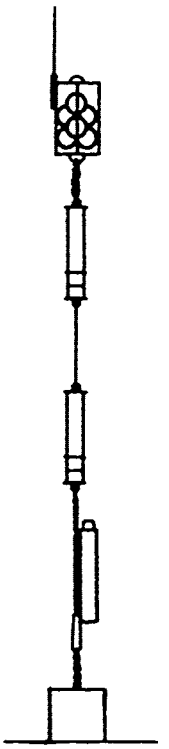
20 m 3/4" NYLON

5m 1/2" CHAIN

STIMSON ANCHOR, 3,200 LBS.

15 FT. CHAIN WITH
65 LB. DANFORTH

STATION 348



LIGHT
RADIO
GLASS BALL FLOAT
1 m CHAIN

CURRENT METER – *3481*

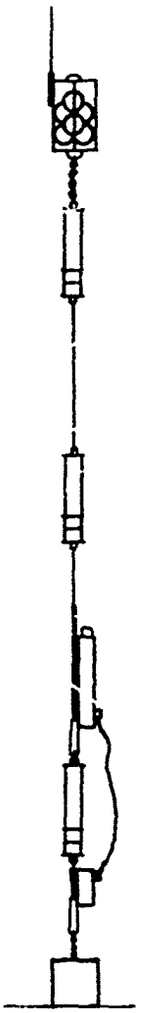
5 m 9/16 NYLON

CURRENT METER – *3482*

ACOUSTIC RELEASE,
TRANSPONDING

1m 1/2" CHAIN
800 LB CYLINDRICAL ANCHOR

STATION 349



LIGHT
RADIO
GLASS BALL FLOAT
1 m CHAIN

CURRENT METER - *3491*

85 m 9/16" NYLON

CURRENT METER – *3492*

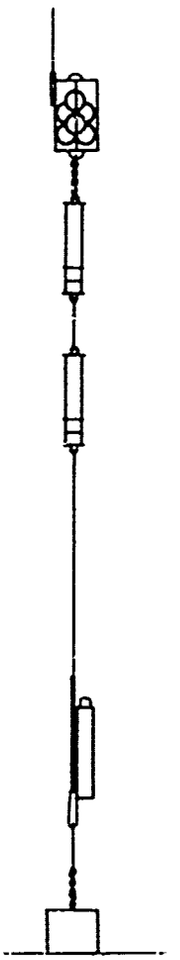
5 m 9/16" NYLON

ACOUSTIC RELEASE,
TRANSPONDING
(ELECTRONICS ONLY)

CURRENT METER - *3493*

ACOUSTIC RELEASE,
TRANSPONDING
(RELEASE MECHANISM ONLY)
800 LB. CYLINDRICAL ANCHOR

STATION 352



LIGHT
RADIO
GLASS BALL FLOAT
1m 1/2" CHAIN

CURRENT METER
(DUMMY)

10 m 9/16" NYLON

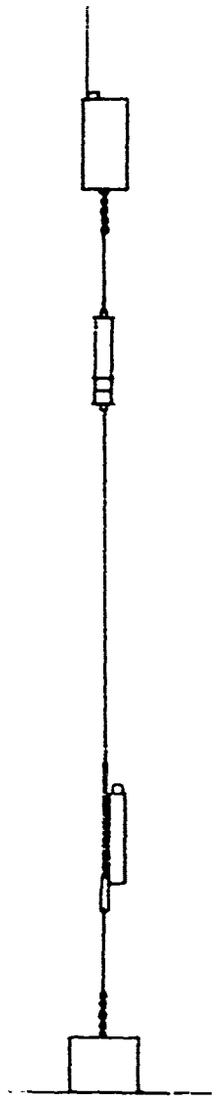
CURRENT METER – *3521*

100 m 9/16" NYLON

ACOUSTIC RELEASE,
TRANSPONDING

10 m 9/16" NYLON
3m 1/2" CHAIN
800 LB. CYLINDRICAL ANCHOR

STATION 353



LIGHT
RADIO
SYNTACTIC FOAM FLOAT
1 m CHAIN

10 m 9/16" NYLON

CURRENT METER – *3531*

300 m 9/16" NYLON

ACOUSTIC RELEASE,
TRANSPONDING

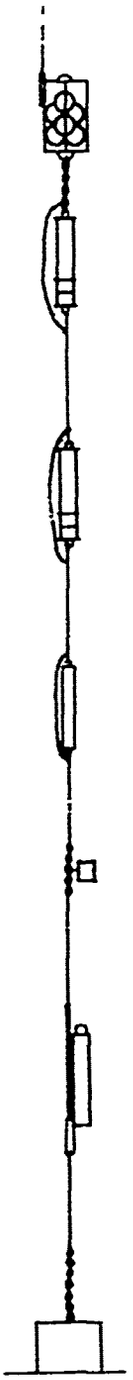
10 m 9/16" NYLON

3m 1/2" CHAIN

800 LB. CYLINDRICAL ANCHOR

STATION 354

ALL LINE
9/16" NYLON



LIGHT
RADIO
GLASS BALL FLOAT

1 m CHAIN

CURRENT METER – *354!*

15 m

CURRENT METER
(DUMMY)

15 m

TENSIOMETER
(DUMMY)

15 m

1 m 1/2" CHAIN WITH BIOPACK – *3542*

15 m

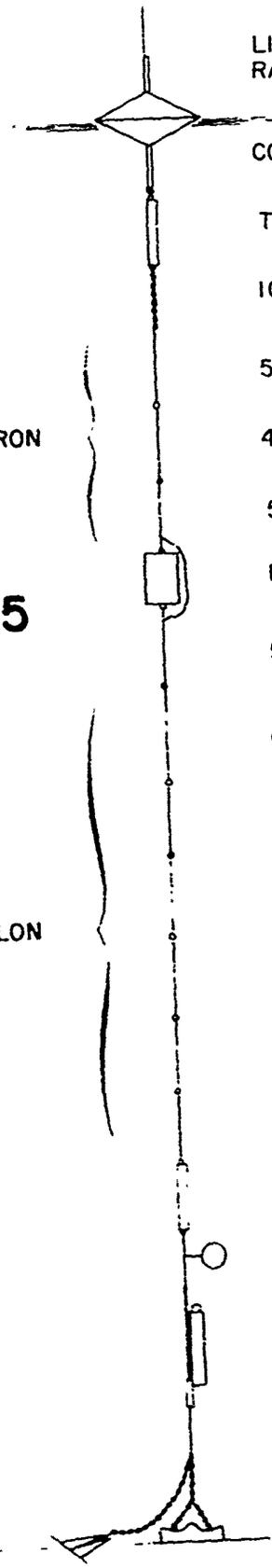
ACOUSTIC RELEASE,
TRANSPONDING

15 m

3m 1/2" CHAIN

800 LB. CYLINDRICAL ANCHOR

STATION 355



LIGHT
RADIO

CONICAL FLOAT

TENSIOMETER

10 m CHAIN

500 m

1/2" DACRON

490 m

500 m

FIBERGLASS FLOAT

500 m 1/2" DACRON

638 m

500 m

529 m

9/16" NYLON

529 m

510 m

509 m

TENSIOMETER – *2551*

85 m 5/8" NYLON WITH 20 GLASS SPHERES EVENLY SPACED

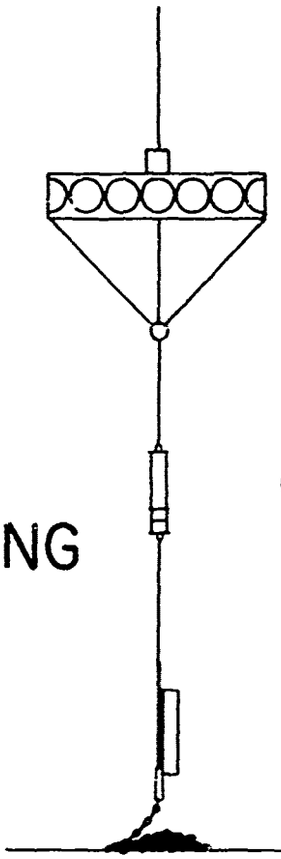
ACOUSTIC RELEASE,
TRANSPONDING

30 m 9/16" NYLON

5m 1/2" CHAIN
STIMSON ANCHOR, 4000 LBS.

15 FT CHAIN WITH
65 LB. DANFORTH

U.R.I.
BOTTOM MOORING



RADIO
18 GLASS BALLS BETWEEN TWO 54" ALUMINUM DISCS

2 FT 9/16" NYLON

CURRENT METER

2 FT 9/16" NYLON

ACOUSTIC RELEASE, NON-TRANSPONDING

250 LBS ANCHOR CHAIN